Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Collective locomotion of two-dimensional lattices of flapping plates[1] SILAS ALBEN, University of Michigan — We study the propulsive properties of rectangular and rhombic lattices of flapping plates at O(10–100) Reynolds numbers in incompressible flow. We vary five parameters: flapping amplitude, frequency (or Reynolds number), horizontal and vertical spacings between plates, and oncoming fluid stream velocity. Lattices that are closely spaced in the streamwise direction produce intense vortex dipoles between adjacent plates. The lattices transition sharply from drag- to thrust-producing as these dipoles switch from upstream to downstream orientations at critical flow speeds. The flows assume a variety of periodic and nonperiodic states, with and without up-down symmetry, and multiple stable self-propelled speeds can occur. With small lateral spacing, rectangular lattices yield net drag, while rhombic lattices may generate net thrust efficiently. As lateral spacing increases, rectangular lattices eventually achieve higher efficiencies than rhombic lattices, and the two types of lattice flows converge. At Re = 70, the maximum Froude efficiencies of time-periodic lattice flows are about twice those of an isolated plate. At lower Re, the lattices' efficiency advantage increases until the isolated flapping plate no longer generates thrust.

[1]NSF DMS-1811889, Mathematical Biology

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Date submitted: 28 Jul 2020

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